

## PRESIDENT KENNEDY'S SPINE HIT BY FIRST BULLET\*

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A WIDELY held misconception about the shooting of the late President John F. Kennedy is that the first bullet to strike the president, which traversed his neck, did not cause a lethal wound. Two lengthy, careful reviews were made (by J.K.L.) of the x rays and photographs of President Kennedy's body, which were taken at the start of the autopsy,<sup>1</sup> and a detailed study was made of the Zapruder motion picture films. These, plus consideration of the neurosurgical (by E.B.S.) and neurological (by H.H.M.) implications of the motions of the president's elbows have led us to the conclusion that President Kennedy's spine was hit by the first bullet to strike him, and that the sudden upward jerk of his flexed elbows was compatible with some degree of trauma (concussive-contusive) capable of creating a lesion of his spinal cord at the level of the sixth cervical vertebra. This was caused by the bullet which entered the back of his lower neck on the right side and preceded the second bullet which destroyed his brain.

Detailed inspections of the x rays of President Kennedy's body, which were taken at the Bethesda Naval Hospital at the beginning of the autopsy, revealed two tiny radio-opaque splinters of what we believe to be bone in the general region of the tip of the transverse process of the sixth cervical vertebra on the right side (Figure 1). These can be seen clearly in one oblique view, which shows the splinters lying just lateral to the spine. In the other x-ray views of that area of the neck, in which the splinters lie superimposed over the bodies of the vertebrae, they are no longer visible. The fact that they are no longer visible has made us suspect that they are bone, rather than fragments of metal. Metal fragments might have con-

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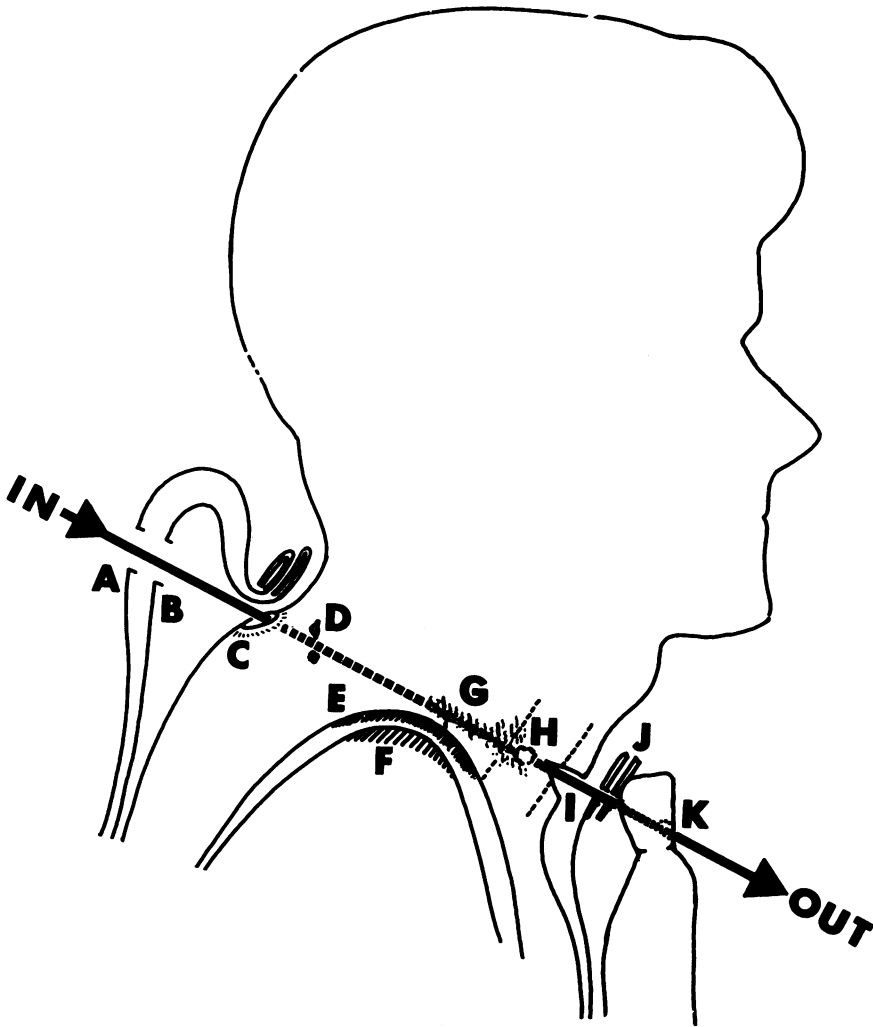


Fig. 1. Diagram of the neck wound. This is a diagrammatic representation of the neck wound of President Kennedy. It is based on observations of the photographs and x rays, but it is not a tracing. (The National Archives requested that no tracings be made, so it is not precise.) Its purpose is to clarify the relative positions of the wounds in the neck and the various findings which, taken together, were consistent with the entry of a bullet into the upper back, which ranged downward and medially through the base of the neck and exited low on the trachea in the midline, just below the collar button, causing a nick on the knot of the necktie. Those findings were as follows: (A) Bullet hole in back of suit-coat and shirt. The president's coat and shirt were probably "humped-up" on the back of his neck when the first bullet struck him. The Federal Bureau of Investigation (FBI) found a punched-in round hole in the back of the coat consistent with a 6.5 mm. bullet, with the broken cloth fibers bent inward, indicating that this was a wound of entry. The cloth fibers of the shirt also were bent inward in the same manner. Traces of copper from a bullet such as Lee Harvey Oswald used were found on the margins of this hole in the coat by the FBI, again

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tinued to show because their density is greater than that of bone. It admittedly is difficult to distinguish between small fragments of metal and bone and it was the first reaction of Dr. Russell H. Morgan of the 1968 panel of experts<sup>2</sup> who first discovered them that they might be metal because they showed up so well. Dr. Morgan agrees, however (in a personal letter to J.K.L.),<sup>3</sup> that the presence of these fragments, regardless of whether they are bone or metal, indicates that the cervical spine was struck (brushed) by the "neck" bullet.<sup>3</sup> He wrote as follows: "Regardless of the nature of the opacities, it seems rather clear to me that the bullet that passed through President Kennedy's neck, brushed the cervical spine, before emerging in front."<sup>3</sup>

#### MODEL CONSTRUCTED

When a row of Carcano 6.5 mm. fully-jacketed bullets of the type used at Dallas was mounted on a rod of thin plastic and positioned across the necks of various skeletons by Gary Lattimer<sup>4</sup> in approximately the same position as the track of the bullet through President Kennedy's neck (Figure 2), it was obvious that the course of the neck bullet lay in the vicinity of the tip of the transverse process of the sixth cervical vertebra (C-6), as shown in Figure 2.

indicating that it was a wound of entrance. (B) Bullet hole in back. The bullet hole in the president's upper back, about two inches below the crease of his neck and about two inches to the right of the midline, was slightly oval. (C) Halo around bullet hole. It had around it a faint but definite dark "halo," or circumferential burned rim, typical of a wound of entry from a spinning, high-speed bullet. (D) Fragments in neck. Two tiny 2 and 4 mm. slivers of what we take to be bone could be seen in the upper (rear) area of the bullet track on the anterior-posterior x-ray film of the right shoulder and neck area. Since no lateral x-ray film was taken of this area, it was possible to determine only that the slivers lay near the high (rear) end of the bullet track, but not the exact distance from the surface. They were near the tip of the transverse process of the sixth cervical vertebra which the bullet may have grazed. They are represented diagrammatically only. (E) and (F) Pleura and lung bruised. The autopsy report described a 5 cm. bruise on the dome of the right pleura and also on the upper tip of the right lung (but no perforation of either), compatible with the passage of a high-speed bullet close above this point. (G) Air in tissues. Tiny traces of air in the tissues along the bullet track near the hole in the trachea were visible in the x rays. (H) Hole in trachea. A ragged hole in the right side of the trachea was seen by the surgeons at Parkland Hospital. (I) Tracheostomy. There was a gaping, 6.5 cm. transverse tracheostomy incision low on the neck, where the Dallas surgeon, Dr. Malcolm Perry, had enlarged the bullet hole in order to insert a tracheostomy tube. (J) Holes on front of shirt. There were 1 cm. vertical slits in both sides of the overlapping portion of the shirt, immediately below the collar band and touching it, just below the collar button. (K) Nick in necktie. There was a nick or crease through only the outer layer of fabric of the lower left side of the knot of his necktie, compatible with the passage of a spinning 6.5 mm. bullet at high speed. A blood stain extended downward from this nick. Reproduced by permission from Lattimer, J. K.: Observations based on a review of the autopsy photographs, x rays, and related materials of the late President John F. Kennedy. *Resid. Staff Phys.* 18:33, 1972.

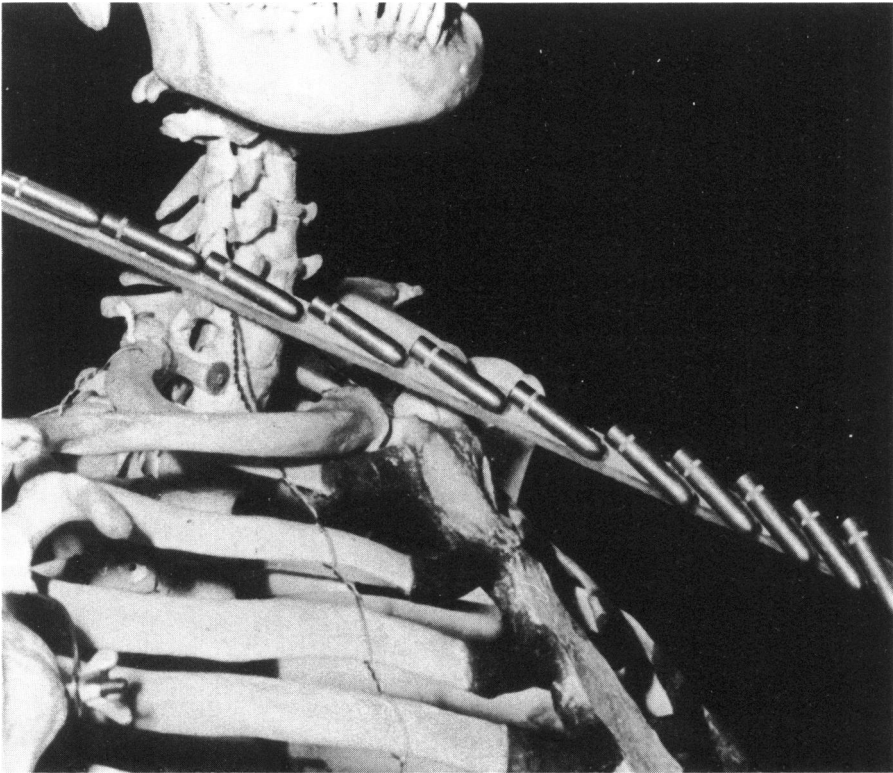


Fig. 2. Tip of president's vertebra. It appears that the first bullet (No. 399) entered the back of President Kennedy's neck and grazed the tip of the transverse process of his sixth cervical vertebra. (Two tiny fragments of bone are visible in the x ray of his neck noted as D in Figure 1.) It then exited with a wobble, starting to tumble end over end as a result of traversing the neck and grazing the bone. It made holes 1/2 in. long, in an up-and-down direction, in both layers of the overlapping part of President Kennedy's shirt front and grazed his necktie knot, leaving a blood-stained nick in the cloth. Reproduced by permission from Lattimer, G., Lattimer, J. K., and Lattimer, J.: The Kennedy-Connally one bullet theory: Further circumstantial and experimental evidence. *Med. Times* 102:33, 1974.

#### TELLTALE MOVEMENT OF ELBOWS

In reviewing the Zapruder film it is apparent that President Kennedy's elbows are beginning to fly upward in frame 225, as he is emerging from behind the Stemmons Freeway sign. It is obvious that he had been struck only a split second prior to this point, because his arms then continued their abrupt upward jerk, to assume a position with the elbows highly elevated, and with both elbows tightly flexed by frame 235 (Figure 3). The reaction is slightly more vigorous by the right arm than the left arm, although the symmetry is impressive. His hands can be seen to fly up to

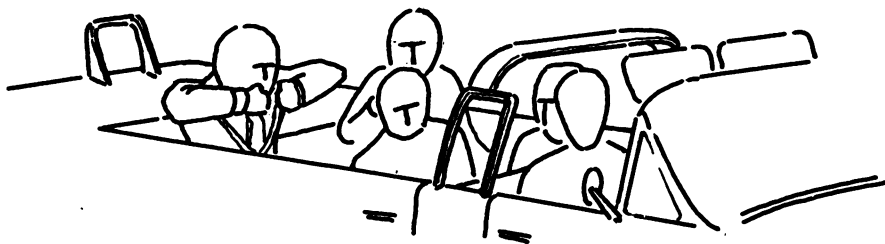


Fig. 3. A drawing taken from frame 235 of the Zapruder film showing the president's elbows in their upward movement. We believe that this upward movement resulted from a stimulation of C-6, some time between frames 220 and 224, with the greatest probability that the spinal cord was injured at about frame 222.

the level of the lower part of his face. It is clear from this that he was not "reaching for his throat" as has been stated or surmised so often. This spasmodic contraction lasts for about 90 frames of the ensuing portion of the Zapruder film, or for about five seconds, although after the first second his elbows begin to sag slightly and he begins to tilt a bit to his left, with his head bowing slightly forward. The fact that he did not crumple down in the seat possibly is due to the fact that he had bound himself up firmly in a rather wide corset, with metal stays and a stiff plastic pad over the sacral area, which was tightly laced to his body. The corset was then bound even more firmly to his torso and hips by a six-inch-wide knitted elastic bandage, which he had wrapped in a figure-of-eight configuration between his legs and around his waist to encase himself tightly, almost like a mummy wrap. He apparently adopted this type of tight binding as a consequence of the painful loosening of his joints around the sacroiliac area, probably a result of his long-continued cortisone therapy.

The effect of the bullet grazing the sixth cervical vertebra was undoubtedly to transmit a sharp concussive-contusive force to the spinal cord at the level of the sixth cervical segment. As Thorburn showed almost 100 years ago in his classic descriptions of patients with cervical cord lesions,<sup>5</sup> trauma to the cord at this segment results in the arms assuming a flexed position with the elbows raised, as can be seen in the illustration from Thorburn's book (Figure 4). The patient of Thorburn's shown in Figure 4 had a spinal cord lesion at C-6, clearly demonstrated at autopsy some days later. Thus, in President Kennedy's case (Figure 3) we have an almost classic demonstration of what might be called a Thorburn position, indicating a lesion exactly at C-6.

The question next arises as to whether the cord below C-6 would have



Fig. 4. Illustration from William Thorburn's original article of 1887 (*Brain* 9: 510-43, 1886-1887) showing the peculiar position assumed by the elbows immediately after an injury at the level of C-6. The caption read: Position occupied by the limbs in a case of complete transverse destruction of the spinal cord immediately below the level of origin of the fifth cervical nerves.

been damaged so badly by even such a glancing blow on the transverse process that it would be physiologically incompetent at the time of the massive brain injury caused by the second bullet, five seconds later.

Naturally, we can only speculate in the most tentative way as to whether the effects of the shock wave that struck the spinal cord sufficiently hard to create a sign also seen with cord transection at C-6 would have been only transitory and, therefore, reversible or not. Nevertheless, because the wound to the cord was not a direct wound, but rather an impulse transmitted from a glancing blow on the most distant part (the tip) of the sixth cervical vertebra, it is certainly conceivable that the spinal cord might still conduct five seconds later. The spinal cord, while traumatized, might still have been able to respond to the effect on the central nervous system of the brain damage secondary to the massive penetrating, perforatory brain injury five seconds later. Most of the right side of the brain was shot away by the second bullet.

The massive cerebral trauma probably was the stimulus for the stiffening of the muscles of the back and the back of the neck, which appeared to assist in pulling President Kennedy's sagging torso upright and backward, about 50 msec. after he was struck by the second bullet. This, necessarily, must be speculation, but it seems well within the range of possibility.

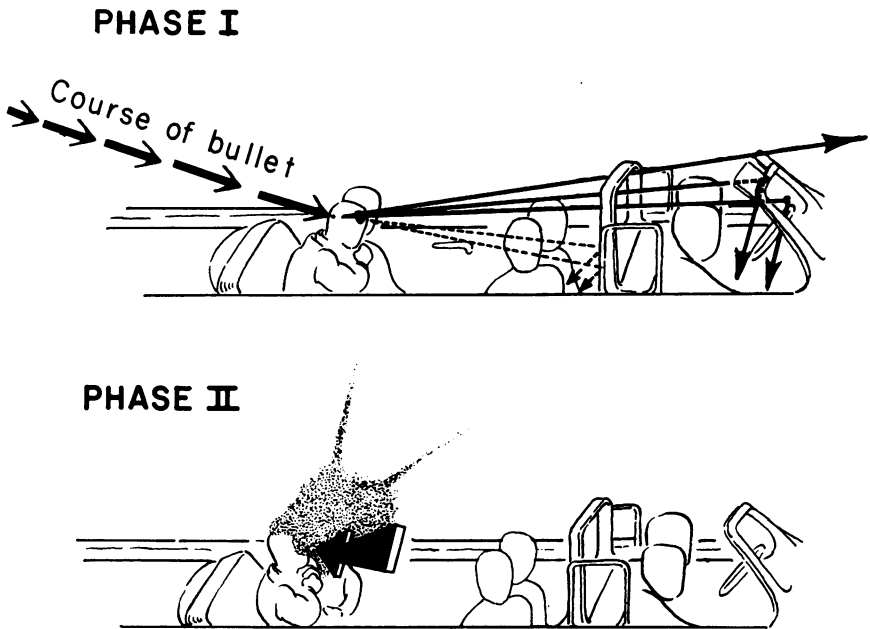


Fig. 5. Head wound. The second bullet entered the president's skull from the rear and broke up. The fragments then diverged and were deflected upward, leaving via a large wound of exit on the front right part of the head (Phase I). The brain then exploded (Phase II), with the largest volume of vaporized, heavy brain substance leaving the skull via the easiest route, through the large wound of exit on the right temple; three additional fragments of skull were blown upward and outward. Since more of the semiliquid, heavy brain substance left the head through the anterior wound of exit on the front right portion of the skull, it created a recoil effect similar to a jet engine (arrow) which helped to drive the president's head backward toward the gun and to his left.

#### RETROGRADE JET RECOIL OF HEAD

The retrograde jerk of the president's head following the brain wound was not exclusively caused by the opisthotonos-like stiffening of his body, however; in our opinion, it was aided by the retrograde recoil caused by the jet of heavy brain substance which flew out of the front of the head through the large wound of exit. This snapped the head backward, similar to the recoil effect produced by a jet engine, and also drove the president's head to his left; since the wound of exit was on the right front side of his head it would cause the head to recoil to the left as well as backward (Figure 5). This effect was demonstrated first on melons by Dr. Luis Alvarez and his associates at Lawrence Berkeley Laboratory<sup>6</sup> and has been reproduced (by J.K.L.) experimentally on several skulls used to simulate

the wounds of President Kennedy as precisely as possible.<sup>7</sup> Certainly, the backward movement of the head did not require a bullet wound from the front or front-right (Figures 6a and 6b).

#### AIR AND BACTERIA IN TISSUES OF NECK

Close inspection of the x rays of President Kennedy's neck taken at Bethesda Naval Hospital at the start of the autopsy showed air in the muscle planes of his neck adjacent to the back of the esophagus and trachea. A large ragged wound of the trachea had made it impossible for the anesthesiologist to insert an endotracheal tube from above, and led to the creation of the large tracheostomy directly across the bullet wound in the throat in order to get a larger endotracheal tube in during the frantic but vain efforts at resuscitation in Dallas.<sup>8</sup>

The contamination of the severely devitalized tissues along the bullet track by bacteria-laden air from the wounded trachea undoubtedly would have resulted in a severe infection of the neck and mediastinum. Any patient on long-term cortisone treatment like the president<sup>9</sup> would have had greatly impaired resistance to infection and greatly impaired healing ability.

If such a patient also had suffered even transitory trauma to the cervical portion of his spinal cord from the same bullet, his chances for survival would have been affected unfavorably from that first bullet alone.

The fact that five seconds after the bullet through the neck a second bullet struck the back of the right side of his head, removing almost all of the right side of his brain (Figures 5 and 6), makes academic the fact that the first bullet also might have been likely to bring about his death by infection and sepsis. The atrophy of the adrenal glands and the long-term cortisone therapy would have made the first wound more lethal than for normal people because of the reduced resistance to infection and the poor healing that cortisone induces.

The precision with which the signs of a spinal cord lesion fit with the other evidence (loose fragments) that the tip of the transverse process of C-6 (not C-5 or C-7) had been struck by the bullet that traversed the president's neck makes it seem almost certain that President Kennedy sustained a traumatic concussive blow to his spinal cord which might have added greatly to his troubles in surviving, even if he had not been hit by the second bullet.



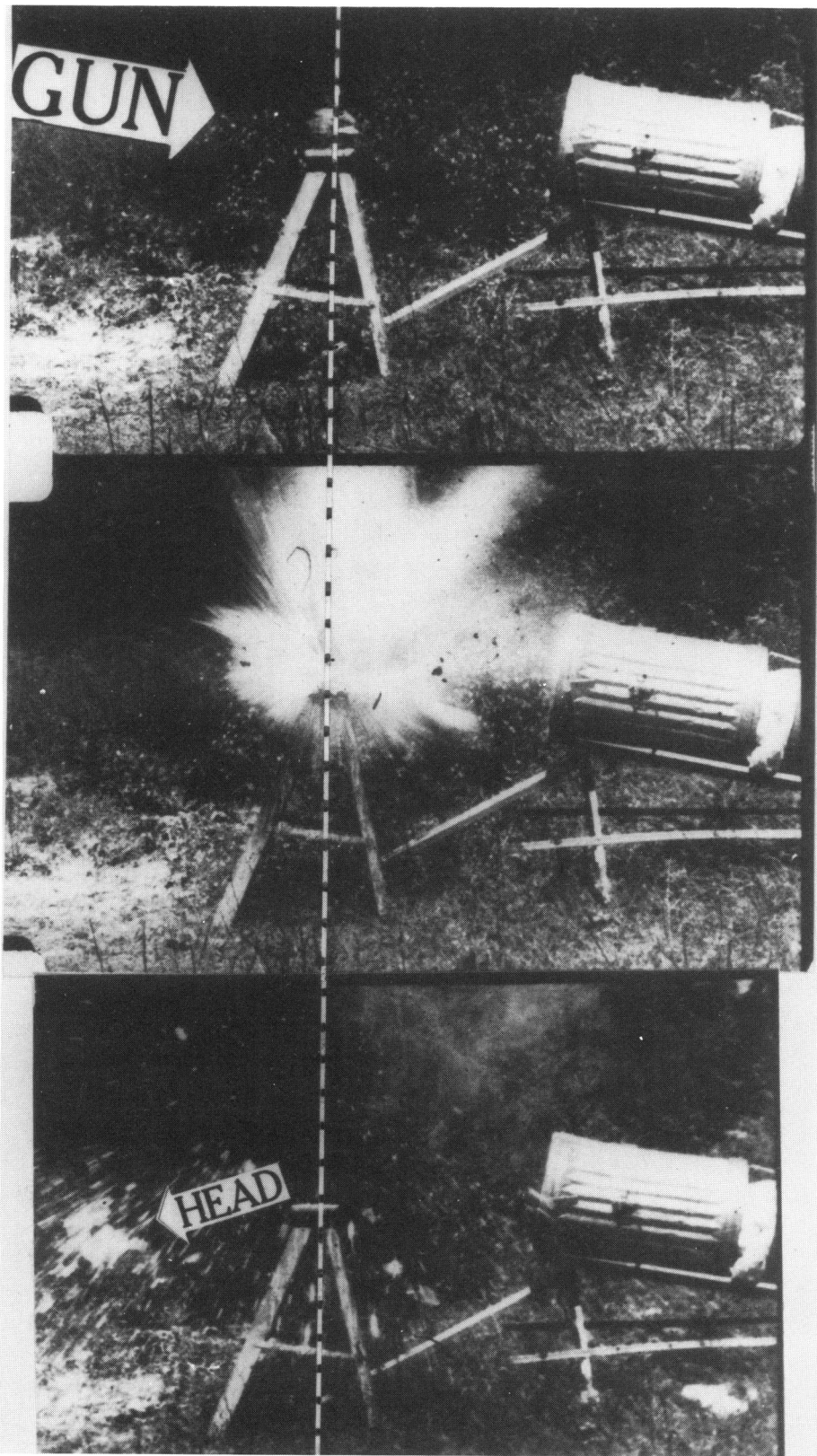


Fig. 6a

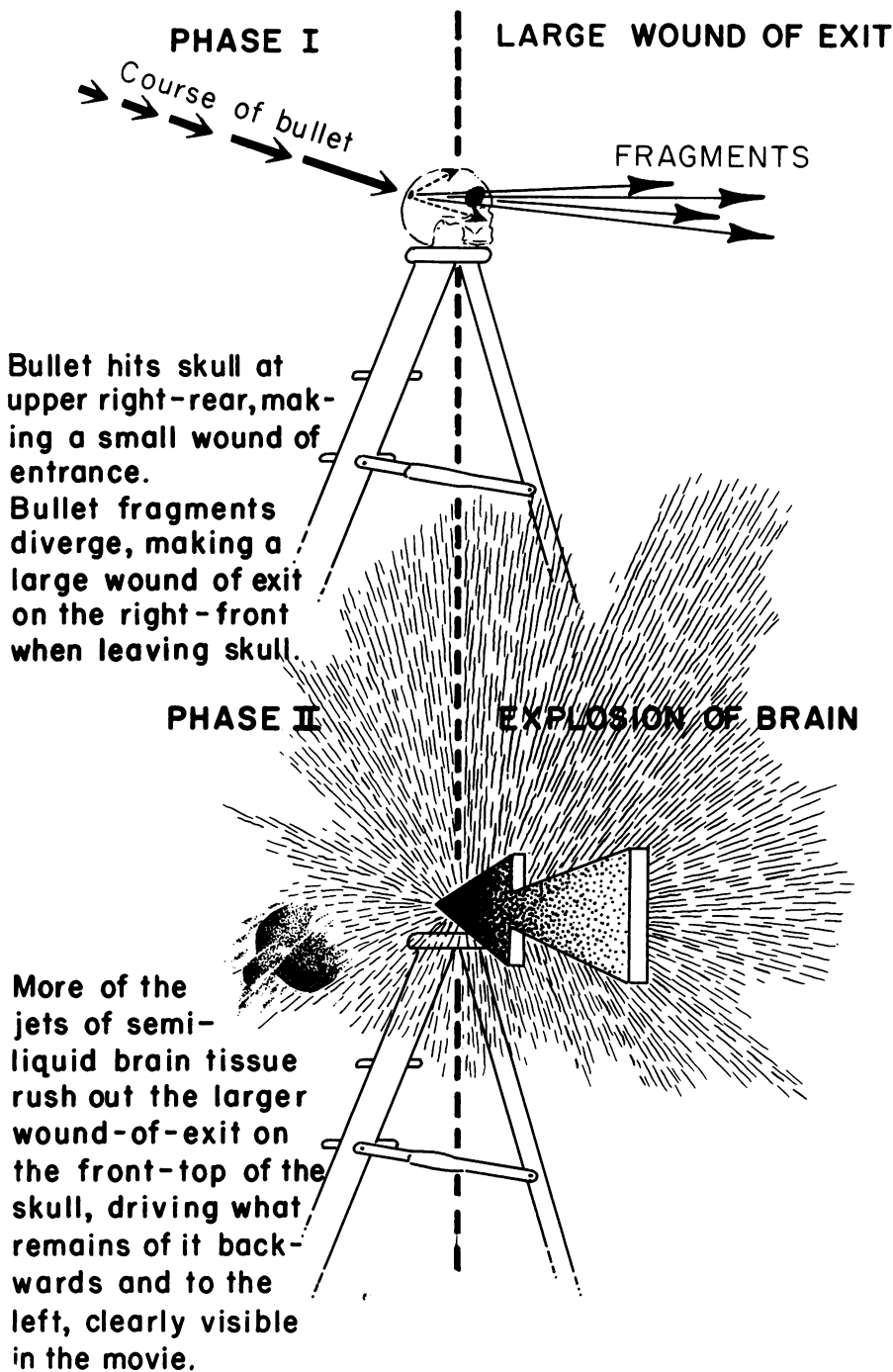


Fig. 6a and Fig. 6b. Experimental demonstration of the backward movement of what was left of the skull after being shot by a fully-jacketed Carcano bullet at the same angle as President Kennedy was hit. Some of the bullet fragments were seen to be deflected upward into the bullet trap (ash can at right packed with cotton waste and fabric). The simulated brain (mixed with white paint to increase visibility) then exploded in Phase II; it can be seen that more of it left the skull in a forward direction (to the right of the dotted line) via the larger wound of exit on the front of the skull. The impact of the bullet in Phase I sometimes moved the skull forward slightly, just before the explosion and backward recoil; however, the explosion was so violent as to dominate the scene. Reproduced by permission from Lattimer, J. K., Lattimer, J., and Lattimer, G.: An experimental study of the backward movement of President Kennedy's head. *Surg. Gynecol. Obstet.* 142:246-54, 1976.

## SUMMARY

The sudden upward jerk of President Kennedy's elbows (Figure 3) just after he was shot in the back of the lower part of his neck is characteristic of a traumatic lesion of the spinal cord at C-6. Thorburn described and illustrated this position of the elbows about 100 years ago in patients whose spinal cord lesions he later pinpointed with precision at autopsy, done a few days thereafter (Figure 4).

The location of two small chips of what we believe is bone, visible in the x rays of President Kennedy's neck (Figure 1), taken just before the start of the autopsy, lie in the general area of the tip of the transverse process of C-6 on the right side. They are in the expected course of the bullet which caused the president's neck wound (Figure 2). Their presence, along with the telltale upward, flexed movements of the president's elbows, is compelling evidence that the bullet hit, grazed, or brushed his spine at C-6.

It seems possible that the traumatized spinal cord would later have become edematous at the very least, leaving the president with neurological problems of unpredictable but substantial extent.

In an embarrassed neurological condition, even if slight, it would have been still more difficult for the president to have overcome the severe infection and edema of the devitalized tissues along the bullet track in his neck and mediastinum from the holes in his esophagus and trachea, which almost certainly would have followed his wounds. His resistance to infection, of course, would have been compromised even more severely by the fact that he had adrenal insufficiency, probably some bladder outlet obstruction, and had been on long-term cortisone treatment.

Thus, it appears all the more conceivable that the president would have died from the first bullet wound to his spine and neck, even if the second bullet had not removed almost all of the right side of his brain five seconds later. His adrenal insufficiency and consequent long-term cortisone treatment would certainly have been a disastrous handicap in a race for survival, compounding any possible further effects from the trauma to his spinal cord.

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